Oxygen uptake rates in a typical gill-breather

2025-02-18

## Practical 1: Assessment

## BSX-2030 Integrated Zoology

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## Task 1

Task 1: Present the data in 4 tables i.e. Tables 6, 7, 8 and 9 from the practical handout. Each table needs a caption. Table titles go above the table

### Table 6 - calculation of Oxygen uptake for crabs in two aqueous conditions

|  | | **A** | **B** | **C** | **D** | **E** |
| --- | --- | --- | --- | --- | --- | --- |
| **Crab Name** | **Treatment** | **Difference in pO2 (mmHg)** | **Time between readings (min)** | **Difference in pO2 in water (mmHg)\*** | **Difference in pO2 accounting for volume (ml)†** | **Oxygen Uptake (ml-1 O2 h-1)‡** |
| A1 | Submerged | 13.3 | 19 | 5.15e-04 | 0.41 | 1.29 |
| A2 | Submerged | 14.3 | 19 | 5.53e-04 | 0.44 | 1.40 |
| A1 | Resubmerged | 15.2 | 15 | 5.88e-04 | 0.47 | 1.87 |
| A2 | Resubmerged | 7.8 | 15 | 3.02e-04 | 0.24 | 0.97 |
| Data collected on 2025-01-30 at Deiniol Road, Brambell Building, 1st Floor Lab B1 | | | | | | |
| \*value from column A solubility coefficient (3.87 10-5) | | | | | | |
| †value from column C vol of water (ml) | | | | | | |
| ‡value from column D () (ml-1 O2 h-1) | | | | | | |

### Table 7 - Oxygen uptake rate accounting for weight and converting to mmol for shore crabs in two aqueous conditions

|  | | **A** | **B** | **C** |
| --- | --- | --- | --- | --- |
| **Crab Name** | **Treatment** | **Oxygen uptake rate (ml-1 O2 h-1)** | **Oxygen uptake rate per unit mass (ml O2 kg-1 h-1)\*** | **Standardised Oxygen uptake rate (mmol O2 kg-1 h-1)†** |
| A1 | Submerged | 1.29 | 48.02 | 2.14 |
| A2 | Submerged | 1.40 | 50.42 | 2.25 |
| A1 | Resubmerged | 1.87 | 69.51 | 3.10 |
| A2 | Resubmerged | 0.97 | 34.83 | 1.55 |
| Data collected on 2025-01-30 at Deiniol Road, Brambell Building, 1st Floor Lab B1 | | | | |
| \*value from column A divided by body mass in kg | | | | |
| †value from column B divided by 22.414 (the conversion ratio between moles and litres). Conversion to mmol is in aid of comparing these values with those calculated in air (Table 8) | | | | |

### Table 8 - Calculating Oxygen uptake for shore crabs exposed to air

|  | | **A** | **B** | **C** | **D** | **E** |
| --- | --- | --- | --- | --- | --- | --- |
| **Crab Name** | **Treatment** | **Universal gas constantassumed temperature ()\*** | **Difference in pO2 (mmHg)** | **Difference in pO2 (mmol O2)‡** | **Difference per unit mass (mmol O2 kg-1)§** | **Oxygen uptake rate (mmol O2 kg-1 h-1)¶** |
| A1 | Aerial Exposure | 17,969 | -0.9† | -3.98e-05 | -1.48e-03 | -1.46e-03 |
| A2 | Aerial Exposure | 17,969 | 1.0 | 4.45e-05 | 1.61e-03 | 1.58e-03 |
| Data collected on 2025-01-30 at Deiniol Road, Brambell Building, 1st Floor Lab B1 | | | | | | |
| \*The universal gas constant is 62.36, the experiment assumes a temperature of 15°C (which is 288.15°K) | | | | | | |
| †The container of crab A1 was found to have increased in partial pressure of Oxygen between readings, which would theoretically mean the crab lost oxygen, it is more likely this is an anomaly. | | | | | | |
| ‡ volume of air in litres (mmol O2). This reflects the equation for the ideal gas law, rearranged to find (to find the quantity of moles of oxygen), | | | | | | |
| §The oxygen difference in millimoles divided by the mass, in kg, for each crab (0.795 for A1 and 0.800 for A2). It should be noted that this step is not in the handout, but I felt it pertinent to include as the values of Oxygen uptake rate for the aqueous samples are in (mmol O2 kg-1 h-1) | | | | | | |
| ¶The value in column C (mmol O2 kg-1 h-1). Time interval recorded for both as 61 minutes | | | | | | |

### Table 9 - Rates of oxygen uptake expressed as mmol O2 kg-1 h-1 in crabs submerged in seawater, exposed to roughly one hour aerial exposure and then resubmerged

|  | **Change in Oxygen uptake rate (Δ mmol O2 kg-1 h-1)** | | |
| --- | --- | --- | --- |
| **Crab Name** | **Submerged** | **Aerial Exposure** | **Resubmerged** |
| A1 | 2.14 | -1.46e-03 | 3.10 |
| A2 | 2.25 | 1.58e-03 | 1.55 |
| Data collected on 2025-01-30 at Deiniol Road, Brambell Building, 1st Floor Lab B1 | | | |

## Task 2

### Table 10 - rates of Oxygen uptake (mmol 02 kg^-1 h^-1) with percentage changes compared to innitial “submerged” reading.

|  | Submerged | Aerial Exposure | | Resubmerged | |
| --- | --- | --- | --- | --- | --- |
| Crab Name | Oxygen Uptake | Oxygen Uptake | % change | Oxygen Uptake | % change |
| A1 | 2.14 | -1.46e-03 | -100.1% ▼ | 3.10 | +44.9% ▲ |
| A2 | 2.25 | 1.58e-03 | -99.9% ▼ | 1.55 | -31.1% ▼ |
| Data collected on 2025-01-30 at Deiniol Road, Brambell Building, 1st Floor Lab B1. Change in Oxygen uptake rate is shown as Δ mmol O2 kg-1 h-1 | | | | | |

Upon initial submersion of the crabs in seawater for 19 minutes, crab A1 experienced an Oxygen uptake of 2.14 mmol 02 kg^-1 h^-1 and crab A2 experienced an Oxygen uptake of 2.25 mmol 02 kg^-1 h^-1, i take these as baselines to compare the other readings with. A2 was heavier, with a weight of 0.0277 kg compared with crab A1’s weight of 0.0269 kg, it should also be noted the volume of the tank for A1 was smaller by 5 ml at 795ml compared with 800ml for A2. Upon aerial exposure, crab A1 was found to have an Oxygen uptake rate of -1.46e-03 (mmol 02 kg^-1 h^-1), this is because an increase of PO2 was measured in the tank for A1, the PO2 for the tank of A2 was found to decrease, leading to an oxygen uptake rate being measured as 1.58e-03 (mmol 02 kg^-1 h^-1), both recordings were calculated over 61 minutes, as shown in Table 8. As shown in Table 10, these values are 100.1% and 99.9% decreases respectively. Compared with initial submersion, crab A1 was found to have in increased rate at 3.10 mmol 02 kg^-1 h^-1, a 45% increase, however, A2 was found to have a rate of 1.55 mmol 02 kg^-1 h^-1, a 31% decrease.

## Task 3

### Discussion

The initial higher reading for A2 can be explained by its bigger size… The negative value is my interpretation assuming the container was air tight, the oxygen came from the crab, it however could be an erroneous reading (give specific numbers)… crabs breathe much worse in air, only able to get one hundredth the amount of oxygen … if my readings can be believed (do the math again)… one crab breathed better, the other worse, perhaps an error in machinery, loose seal means the O2 increased in air and water got more aerated for submersion. or maybe the crabs just reacted differently by chance, with only these samples who knows (have a look at literature to see which is more likely, is better or worse breathing after air more common?)… possible stress… gender not taken… i recommend pooling the class data so statistical analysis can be done on it… (rule out errors, find significance, that sort of stuff) i created a 10th table on my own time using R to calculate the percentage change with the values as I hope this is a transparrent way of displaying the information. (not exactly this, but mention 10 and the use of R)…